20 meter superhet RADIO EVAN (160)
20 m rig EVEREST

Tuesday
Feb 26 1987?

Dear Dad,

Enclosed are copies of the articles I am using to build my QRP transceiver. Other recent projects include "un-earthing" my aim-65 and the digitalker. Rockwell no longer handles the aim, but I found out who does (there is a local distrubutor in Orlando). I'm going to try getting a replacement display module for my aim.

Thanks for the phone conversation Sunday. I enjoyed talking with you.

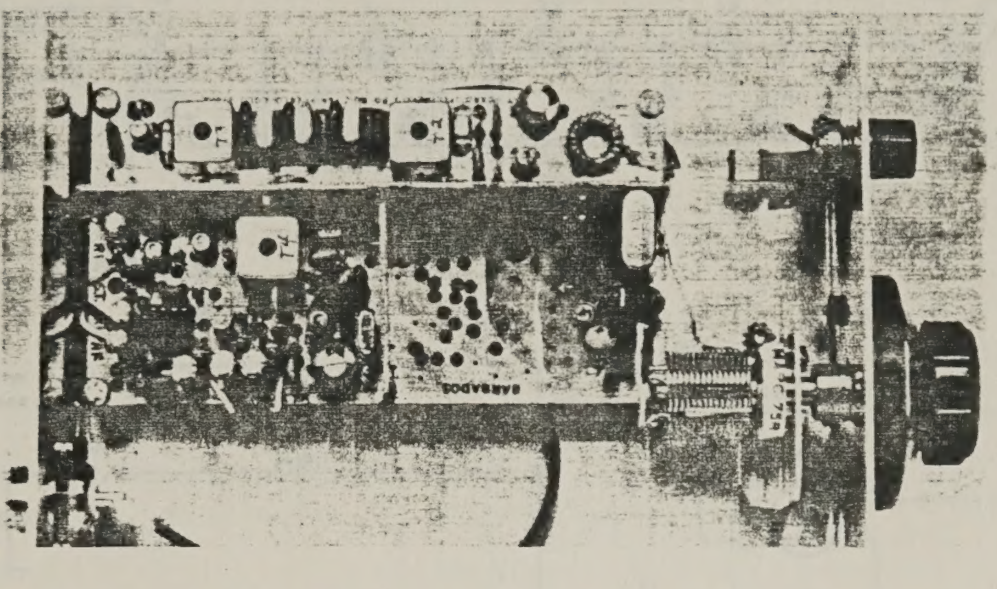
Love,
Evan

QRP

(160)

JUNE '82 QST

Build a Bare-Bones CW "Superhet"



Low cost, minimum stage count and excellent cw selectivity are yours for 20-meter portable or QRP operation with the simple receiver in this article. Eliminate the frills and save $!

By Doug DeMaw,* W1FB

Tired of working with D-C (direct conversion) receivers because they do not provide single-signal reception? Because they are prone to common-mode hum? And how about problems with microphonics? If these are familiar laments, perhaps it's time to consider building a *superheterodyne* cw receiver for use in your portable setup. The foregoing maladies will no longer confront you with the circuit described here. It can be used on 40, 15 or 10 meters by changing the local-oscillator frequency and modifying the mixer input tuned circuit. No other changes are required. If the bare-bones format doesn't appeal to you, consider the circuit as a foundation to which you may add all manner of goodies, such as a speaker amplifier, rf amplifier, tunable L-C local oscillator or even agc.

Design Rationale

My objective at the drawing board was to develop a simple circuit that contained the minimum number of stages to yield acceptable performance in terms of sensitivity, dynamic range and overall gain for use with headphones. Other goals were good oscillator stability, easy availability of components and low current drain. These aims were realized with the circuit of Fig. 1. Cw selectivity is 260 Hz at the −6 dB points on the response curve, current drain is only 12 mA when using a 12-volt dc supply and there are but seven stages in the receiver. Overall gain is approximately 100 dB — more than ample for good headphone volume, even when copying weak signals. Finally, I wanted the receiver module to be relatively small. Bob Shriner, WA0UZO, made this possible with his pc-board layout, which was developed from my circuit diagram. He even included extra holes to accommodate an L-C type of local oscillator in place of the specified VXO.

Circuit Information

There is no rf preamplifier in the circuit of Fig. 1. If the receiver is to be used on 15 meters, I recommend adding the rf amplifier of Fig. 2 to improve the noise figure. This amplifier is not necessary for 40- or 20-meter operation, although some builders may want to include it for 20-meter reception if they operate in very quiet locations (low levels of man-made and atmospheric noise).

Signals from the antenna are fed directly to the mixer, Q1, through a simple front-end resonator (T1 and C1). The Q of the circuit is high enough to provide good selectivity, but not so high as to limit the desired response within any 50-kHz tuning range of 14 or 21 MHz. The trimmer (C1) is set for peak signal response in the center of the desired tuning range. A panel-mounted miniature air variable capacitor can be substituted at C1 for 40-meter operation. This is suggested because of the greater tuning range of the receiver with the L-C oscillator (200 kHz), and because the bandwidth of the input circuit will be half of that for 20-meter operation (assuming an identical value of Q for the resonator in each case).

The mixer and product-detector stages were chosen to provide gain; hence passive devices were not used at Q1 and Q3 of Fig. 1. This aids in minimizing the number of stages required for good overall gain.

A VXO (variable crystal oscillator) was my choice for the local oscillator in order to simplify the circuit and ensure high stability. Q4 of Fig. 1 operates as a series-tuned Colpitts oscillator, which provides a tuning range of roughly 30 kHz when using 17-MHz fundamental crystals.

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*QST Senior Technical Editor

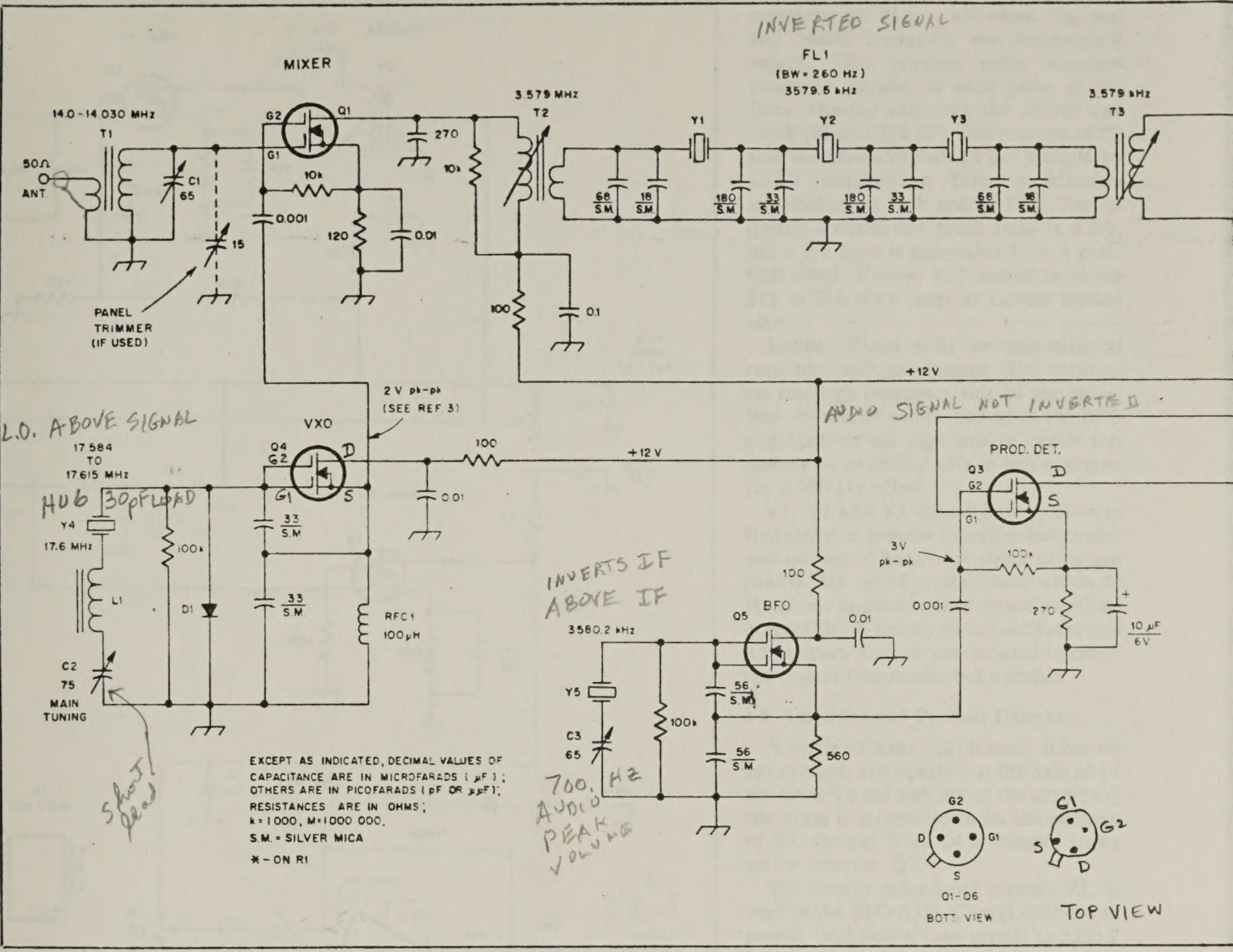

Fig. 1 — Schematic diagram of the simple superheterodyne receiver. Fixed-value capacitors are disc ceramic. Polarized capacitors are electrolytic or tantalum. Fixed-value resistors are 1/4- or 1/2-watt composition. S.M. indicates silver mica. NPO ceramic or polystyrene capacitors may be substituted for those with S.M. indicated.

C1 — PC-mount trimmer, except for 40 meters. Use panel-mounted air variable for 40 meters.
C2 — Miniature 75-pF air variable. Main tuning, use vernier drive.
C3 — Same as C1 for all bands.
D1 — Silicon diode, 1N914 or equivalent.
D2, D3 — Radio Shack Schottky diode, or equivalent.
FL1 — Ladder filter, 260-Hz bandwidth (see text).
L1 — 6-μH toroidal inductor. 36 turns no. 26 enam. wire on Amidon T50-6 toroid core. 50 A_L = 47, powdered iron. 25
Q1-Q6, incl. — Dual-gate MOSFET, 40673 or 3N211. MPF102 or 2N4416 suitable for Q4, Q5 and Q6.
R1 — 10-kΩ, audio-taper, composition control.
RFC1 — Miniature rf choke, 100 μH. Value not critical.
T1 — Input transformer, toroidal. For 15 meters, 1.9 μH (20 turns no. 26 enam. wire over entire T50-6 core, link = 2 turns). For 20 meters, 3.2 μH (26 turns no. 26 enam. wire on T50-6 core, link has 2 turns). For 40 meters, 13 μH (51 turns no. 28 enam. wire on T50-2 core, link 5 turns).
T2, T3 — Miniature transformer, 4.7:1 turns ratio, 6.5 μH. (27 turns no. 28 enam. wire on bobbin of an Amidon [Micrometals] L57-2 transformer assembly. Use 6 turns for the link.)
T4 — Same as T2 and T3, but with the primary center tapped.
U1 — Op amp, 741 or Radio Shack TL081.
Y1, Y2, Y3, Y5 — Radio Shack TV color-burst crystal, 3.5795 MHz. Do not substitute without redesigning FL1 in accordance with Note 2.
Y4 — Fundamental crystal in HC-6/U-style holder. Same general range for 20 and 15 meters. Select for portion of the bands to be tuned. International Crystal Co. type 434110, 30 pF load capacitance, recommended (10 N. Lee St., Oklahoma City, OK 73102).

Overtone crystals (52.8 or 88 MHz) that have fundamental frequencies on or near 17.6 MHz can be used, but they will yield less tuning range. Also, they will commence oscillation somewhat lower in frequency than will the fundamental types. A 30-pF load capacitance should be specified when ordering Y4, and it should be in an HC-6/U style of holder. The tuning characteristic for C2 is nonlinear. That is, the rate of frequency change is much faster near the minimum-capacitance setting of C2, and the rate decreases as maximum capacitance is achieved.

The VXO can be used for 40-meter operation if the builder is willing to accept a limited tuning range — generally 5 to 10 kHz maximum. The amount of frequency shift varies with the crystal used, and is unpredictable, even when seemingly identical crystals are supplied by a given manufacturer. Large frequency spreads are possible by increasing the inductance of L1 (Fig. 1), but the circuit no longer functions as a true VXO. The oscillator degenerates to a conventional L-C type of device, and the frequency stability declines accordingly. You may want to experiment along these lines when building a 40-meter version of the unit. If ambient temperature changes aren't too severe, stability may be entirely acceptable. I did

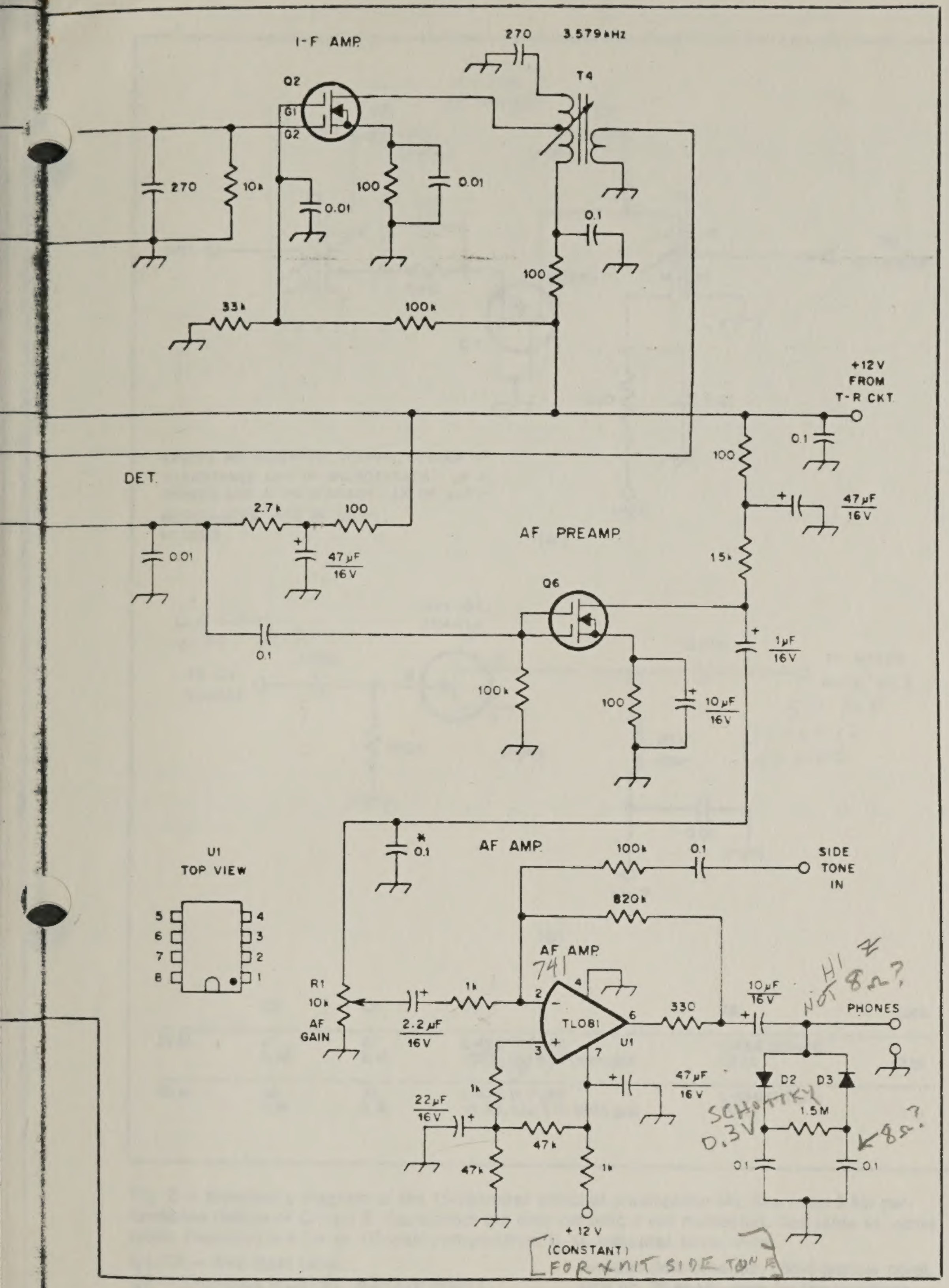

FIG. 1

not investigate this matter while testing the circuit.

I-F Filter

A major expense when building a narrow-bandwidth receiver is the i-f filter (FL1 of Fig. 1). In order to indulge my miserly ways, I chose a 3-pole ladder filter, designed for a 250-Hz bandwidth. Color-TV burst crystals are easy to obtain and are inexpensive, so I used them as filter elements. This provides an i-f of 3.5795 MHz, which of course rules out operation of the receiver on 80 meters. With the help of my colleague, Wes Hayward, W7ZOI, the four Radio Shack crystals (Y1, Y2, Y3 and Y5) I purchased were checked for unloaded Q and series resistance. These parameters must be known before calculating the values of the end and center capacitors in the filter. The correct terminal impedance is also derived from that information. W7ZOI has developed a computer program that "whistles" out the answers when the Q and series resistance of the crystal are known.① His program provided the values specified in this article. The Q of the Radio Shack crystals is 105-kΩ, and the series resistance is 38.6 ohms. To ensure minimum band-pass ripple, it is important to provide the computed terminal resistance for FL1 — 450 ohms. The end and center capacitors are nonstandard values. This requires using standard values in parallel at each point in the filter, thereby achieving the desired end result (85 and 212 pF). The primary of T2 and the secondary of T3 are bridged by 10-kΩ resistors to force a 450-ohm termination at each end of FL1. The required transformer turns ratio is 4.7:1, but a 5:1 ratio is acceptable from a practical point of view. FL1 should be in the $12 to $15 price range at current market rates.

Ladder filters yield an asymmetrical response, with the steepest skirt occuring on the high-frequency side of the curve. Best cw results will be had when the BFO is placed on the *high* side of center frequency — at 3580.2 kHz in this example, for a 700-Hz offset.

Y1, Y2 and Y3 should be very close in frequency to prevent excessive bandwidth and unwanted band-pass ripple (dips and peaks). My set of crystals were within 50 Hz of one another, which turned out to be acceptable. A simple crystal oscillator and a frequency counter can be used to check the crystal frequencies beforehand.

I-F Amplifier and Product Detector

A single i-f stage (Q2) is used. It has no agc applied, and operates at full gain all of the time. To aid stability of the amplifier, the drain is tapped down on the primary of T4. Output from T4 is coupled to an active detector, Q3.

The fourth color-burst crystal, Y5, is used in the BFO (Q5). C3 was included to permit "rubbering" the crystal to 3580.2 MHz, thereby ensuring the 700-Hz offset discussed earlier. Tune C3 for a 700-Hz audio note peak.

Audio-Amplifier Section

A dual-gate MOSFET is used as the af preamplifier (Q6) to help establish a low noise figure in that part of the circuit. A 0.1-µF bypass capacitor at the high side of control R1 is used to roll off some of the high-frequency hiss in the receiver. This aids the overall noise figure of the receiver. Larger values of capacitance will further reduce the noise, but will cause some attenuation of the output signal.

A 40-dB-gain op amp (U1) serves as the headphone amplifier. A 1-kΩ resistor has been placed between R1 and pin 2 of the amplifier to prevent self-oscillation when R1 is at the extreme ends of its range. Oscillation will otherwise occur when using low-impedance phones with the receiver (8-ohm hi-fi phones in particular). The resistor prevents significant changes in the op-amp feedback when R1 is set for maximum or minimum audio gain. The 330-ohm resistor at pin 6 of U1 also aids the stability.

A self-adjusting audio limiter (D2, D3) helps to prevent very loud signals from "shattering" one's ears while tuning the

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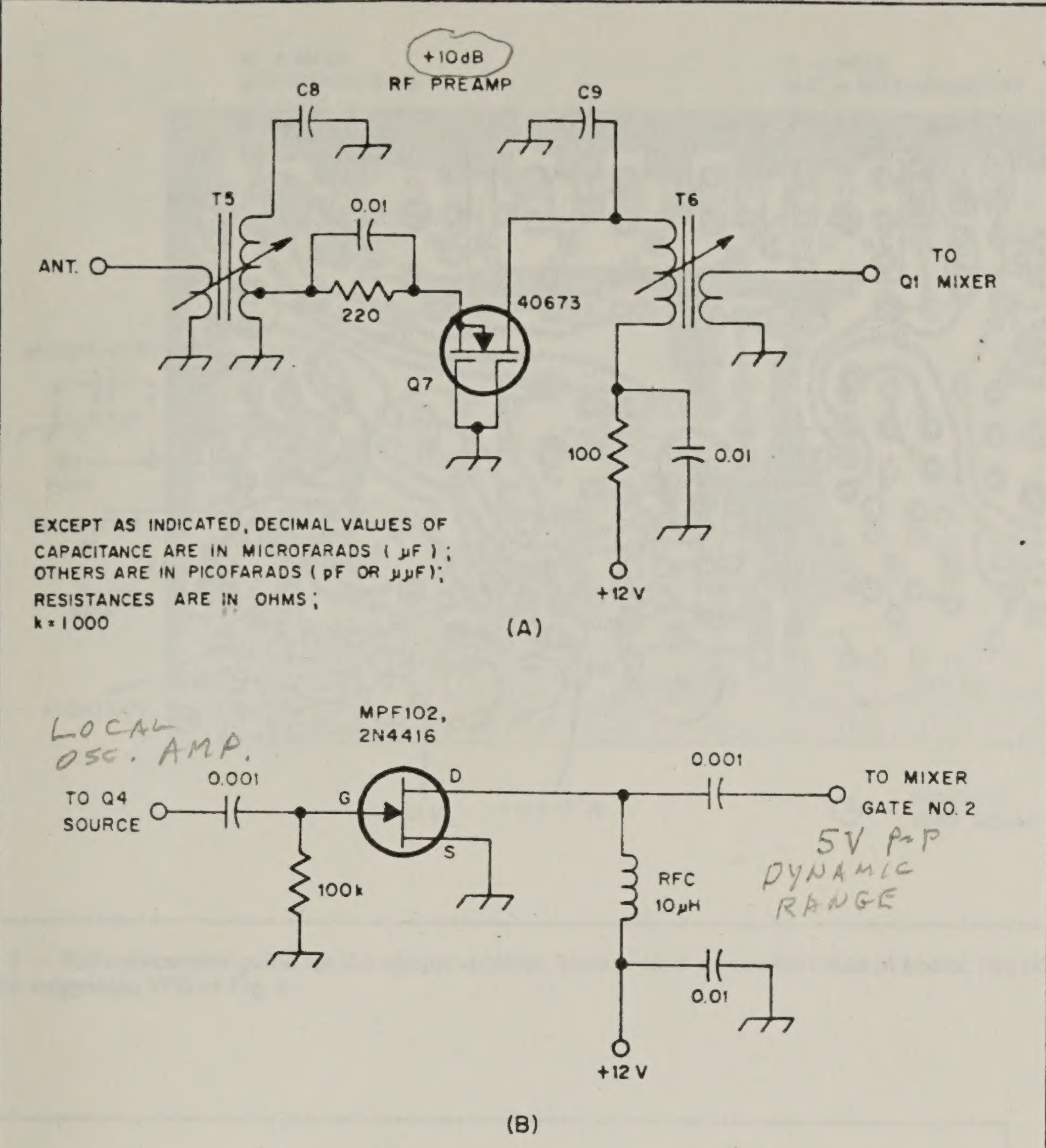
¹Notes appear on page 33.



	C8	C9	T5	T6	Link
20 M	47 S.M.	47 S.M.	L-43-6 (2.6 µH) 18TS, tap 6 ts from gnd	L-43-6 (2.6 µH) 18 ts	2 ts
15 M	33 S.M.	33 S.M.	L-43-6 (1.7 µH) 15 TS, tap 5 ts from gnd	L-43-6 (1.7 µH) 15 ts	2 ts

Fig. 2 — Schematic diagram of the 15/20-meter optional preamplifier (A). See Note 3 for performance details of Circuit B. Capacitors are disc ceramic if not numbered. See table for other types. Resistors are 1/4- or 1/2-watt composition. S. M. indicates silver mica.

C4, C5 — See inset table.

Q7 — Dual-gate MOSFET, 40673 or 3N211. JFET may be substituted.

T5 — See table. Transformer assembly is an Amidon (Micrometals) L56-6 (yellow core). Use no. 26 enam. wire for the windings. Ground shield cans to pc-board ground.

receiver. Schottky diodes should be used to take advantage of the low barrier voltage (0.3 V). These can be purchased at Radio Shack stores. Silicon diodes, such as the 1N914 type, start to clip at 0.7 volt, which is too high for listening comfort. The limiter circuit can be regarded as poor man's agc. However, large signals will cause considerable audio distortion in U1 unless the gain control, R1, is used to reduce the gain to normal headphone level. This is the major trade-off for not including agc in the receiver circuit.

Construction

Circuit boards and complete parts kits for the receiver of Fig. 1 are available.[2] A scale pc-board pattern appears in the Hints and Kinks section of this issue of *QST*.

My version of the receiver will eventually become part of a 10-watt, 20-meter trans-receiver for portable use and camping. To that end I included an input line to pin 2 of U1 (Fig. 1), intended for introducing sidetone for cw monitoring. Also, the 12-volt line to U1 is separate from that which feeds the remainder of the receiver. This allows U1 to remain operational at all times (necessary for sidetone monitoring). The main 12-volt line can then be turned on and off via a T-R (transmit-receive) switching circuit in the mating transmitter. The antenna will be switched in a like manner.

Packaging can be tailored to your needs. If the lead from the antenna jack to T1 is more than 2 or 3 inches long, use miniature coaxial cable for the connection and ground the shield braid at both ends of the line.

Performance

This receiver is not intended as a high-performance or state-of-the-art example. Rather, the design was done to meet the objectives of simplicity, low cost and small size. The dynamic range is approximately what one would expect at 20 meters when a dual-gate MOSFET is used as a mixer (single-ended) and is not preceded by a low-noise rf amplifier. The MDS (noise floor) measured −117 dBm. Blocking commenced at 96 dB, and the IMD number was 67 dB — not spectacular, but entirely adequate for the intended application.[3] This is still as good as or better than the numbers obtained when testing some pieces of commercial receiving gear in the ARRL lab.

Various segments of the band of interest can be tuned by changing crystals at Y4. In my case, I'm interested primarily in the range from 14,000 to 14,030 kHz. One crystal provides that coverage. The crystals will oscillate (C2 unmeshed) approximately 12 to 15 kHz higher than the marked value. This must be taken into account when ordering your crystal. This may not be true if other VXO circuits are used. Make certain that the rotor lug on C2 has a short lead between it and the ground foil of the pc board. If not, the VXO may perform poorly, and the tuning range may be restricted. The rotor should be grounded also to the receiver case or chassis.

Operation on 15 meters can be realized by using a crystal (Y4) in the same general range as for 20 meters. However, the receiver tuning will be backward from that on 20 meters.

A parts-placement guide is shown in Fig. 3. Information is given for a VFO that is suggested for 40-meter operation. The VFO circuit is presented in Fig. 4.

Although 10-meter operation is possible with all but the VXO, the limiting factor is the unavailability of fundamental crystals for the local-oscillator at the required 24,450 kHz frequency. The alternative would be to use a VXO crystal at half that frequency, then route the output through a doubler (push-push type preferred).

The receiver could be set up for 160 meters by changing the input tuned circuit and using a VFO in the 5.5 MHz range. By selecting the proper VXO crystal frequency and modifying T1, it would be practical also to employ the receiver on the WARC bands (10, 18 or 24 MHz).

Whatever your preference, the simple superhet can serve your portable needs in

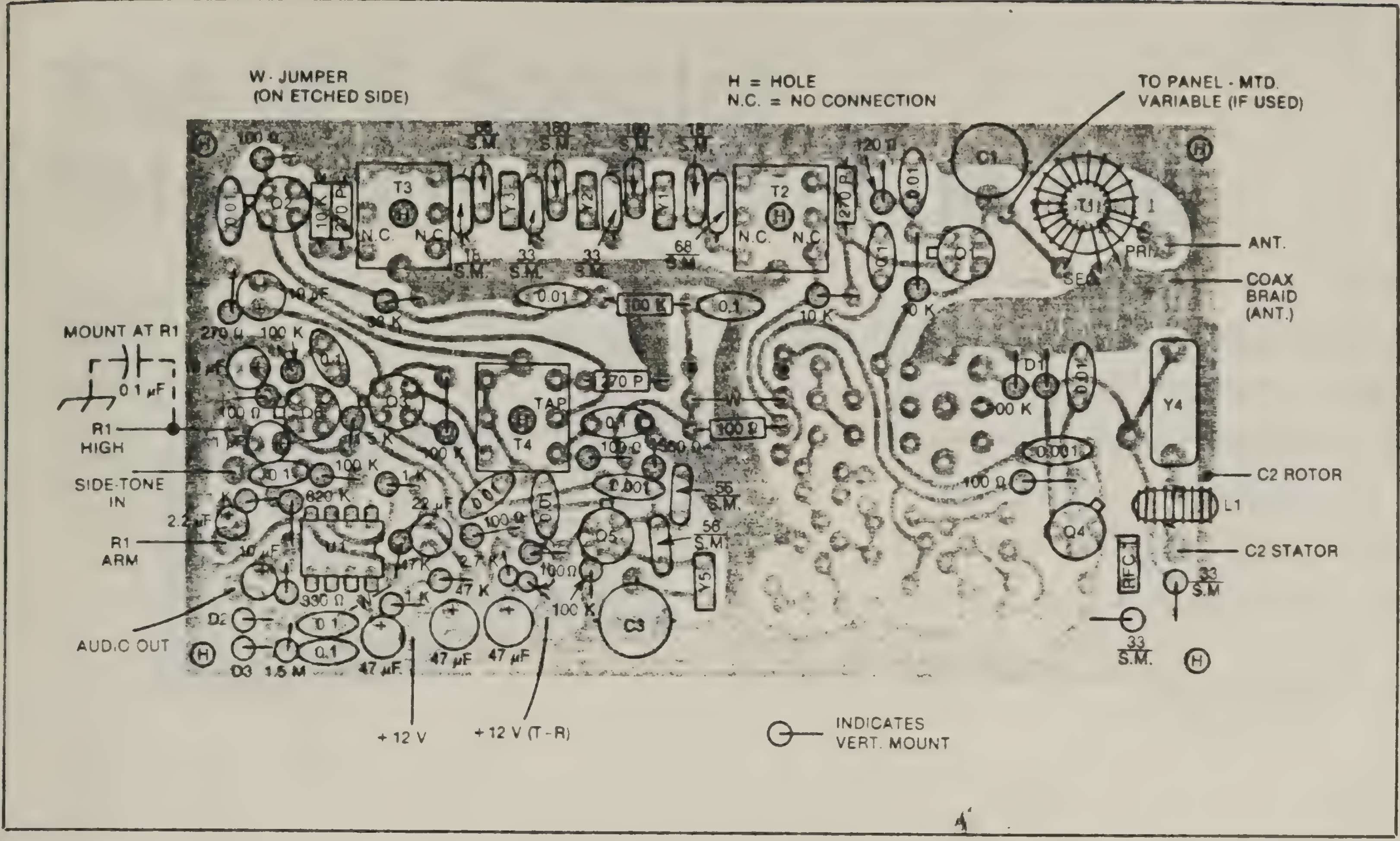
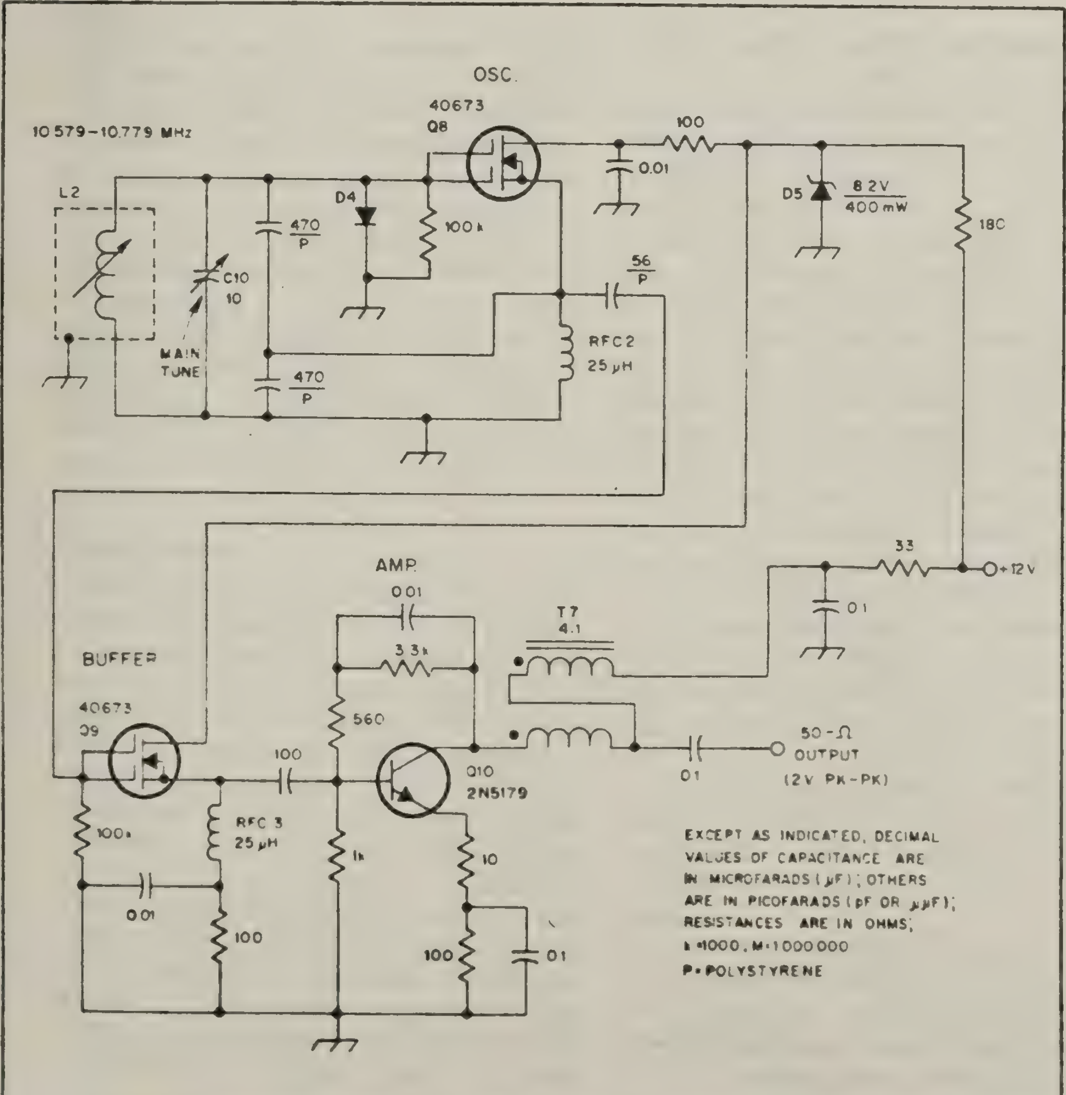


Fig. 3 — Parts-placement guide for the simple receiver. View is from component side of board. The LO section will accommodate the VXO of Fig. 1 or the suggested VFO of Fig. 4.



40M VFO

Fig. 4 — VFO circuit for use on 40 meters. With specified tuning range of Q8, coverage on 40 meters will be 7.0 to 7.2 MHz. Fixed-value capacitors are disc ceramic unless otherwise noted. Resistors are 1/4- or 1/2-watt composition.

C10 — Miniature 10-pF air variable, double-bearing type recommended for best mechanical stability.
D4 — Silicon diode, type 1N914.
D5 — Zener diode.
L2 — Inductor, 0.9 µH. Use 10 turns no. 24 enam. wire on bobbin of an Amidon L57-6 transformer assembly.
Q8, Q9 — Dual-gate MOSFET or 2N4416-family JFET.
RFC2, RFC3 — Miniature rf choke, approximately 27 µH.
T1 — Broadband, bifilar transformer, 4:1 impedance ratio. Use 10 bifilar turns of no. 24 enam. wire on Amidon (Fair-Rite) FT50-61 ferrite toroid core. Observe phasing dots when connecting to circuit.

fine style. Not only that, it provides a simple short-term workshop project for those who enjoy building homemade equipment. QST

Notes

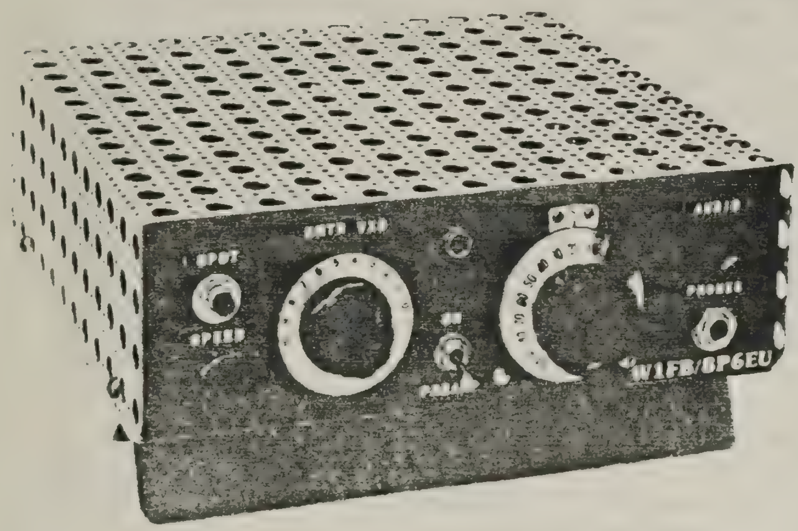
[1] W. Hayward, "A Unified Approach to the Design of Crystal Ladder Filters," *QST*, May 1982; pp. 21-27.

[2] Negatives, pc boards and parts kits for this receiver are available from Circuit Board Specialists, P.O. Box 969, Pueblo, CO 81002.

[3] The dynamic range can be improved by increasing the LO injection of the mixer from 2 volts pk-pk to 5 volts pk-pk. The latter is the prescribed level for optimum performance of the 40673 mixer. See Fig. 2B for circuit details.

Nov 82
QST

The 8P6 Special — "Hamcation" Backup Rig



Campers, travelers, vacationers and DXpeditioners require compact, lightweight gear. This trans-receiver for 20 meters fits the description and is not difficult to build.

By Doug DeMaw,* W1FB

Worried about a breakdown with your primary station on a "hamcation" (ham radio vacation)? Need a small rig for a business trip or a weekend holiday? Or how about that camping trip you've been planning? No doubt a trans-receiver that can be operated from a 12- to 14-V dc power source, and which can deliver 6 to 8 W of properly shaped cw into a 50-ohm load, would appeal to you. By way of added features, how about including a single-signal superheterodyne receiver with a 250-Hz i-f filter and rock-stable frequency control of the transmitter and receiver sections?

Some Features

I've carried all manner of QRP transceivers and "separates" on junkets to various West Indies islands over the years, mainly as a backup to the primary equipment. Most of them have worked well in a pinch — when the commercially made transceiver failed. But, most of the homemade units contained direct-conversion (D-C) receivers, which did not provide the cw selectivity I desired. Futhermore, single-signal reception was not possible, which compounded the QRM problem — especially in pileups! Since a bare-bones superheterodyne receiver is scarcely more expensive or complicated to build than is a high-performance D-C receiver, the former was my choice for this project. The receiver section of the trans-receiver was described earlier in *QST*[1]; therefore, I will key this article to the remainder of the circuit in the portable unit.

Long-term frequency stability is of the utmost importance to dependable dial calibration and effective operating. Large changes in temperature are prevalent from day to night in the tropics and when camping. Some simple L-C VFOs fail to "measure up" in the presence of radical shifts in ambient temperature, sometimes drifting more than 5 kHz over a 20° F temperature change. I chose VXO (variable crystal oscillator) control for the receiver and transmitter sections of this QRP station and could detect no discernible drift in either circuit during two weeks on Barbados as 8P6EU. Chirp-free cw was obtained from the transmitter, and one operator I contacted remarked, "Boy, it sounds like you're keying a frequency standard." A tape recording of my 8P6EU signal (courtesy of N1FB) verified the "sanitary" sound of the signal.

The portable package contains a Curtis Lil' Bugger keyer ($29.95, from Curtis, minus case and speed control); a twin-T sidetone oscillator, break-in delay module for T-R switching; and a switchable 15-dB preamplifier for use ahead of the receiver, as desired. A block diagram of the composite circuit is given in Fig. 1.

Transmitter Circuit

An excellent 20-meter transmitter was designed by former Hq. staff member W1VD for use in the Project Goodwill program.[2] It was chosen for use in my trans-receiver, and some modifications were made to (1) increase the VXO frequency swing; (2) shape the cw waveform; (3) provide diode switching for T-R control; and (4) add decoupling networks to ensure unconditional stability of the low-level stages. A bipolar dc switch was also added for keying control, as were heat sinks on Q3, Q4 and Q5.

All of the modifications are included with the original circuit on a new pc board that is the same size as the original one.[3] The circuit performance is otherwise unchanged from that of the original W1VD design. Circuit details are given in Fig. 2.

The Curtis keyer has a sidetone circuit, which can be used in place of the twin-T audio oscillator in this design. The duplication of sidetone availability resulted from the Curtis unit being added as a last minute convenience before the Barbados trip.

A spotting switch has been included to permit zero beating the receiver to the transmitter frequency, or vice versa. When spotting is done, the operator should tune for a pitch of approximately

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*Senior QST Technical

700 Hz to ensure that the transmitter frequency closely approximates that of the station being worked. Because of the twin VXO feature of this trans-receiver, no RIT is required, and wide transmitter-receiver frequency splits are possible.

The VXO Circuits

Greater frequency coverage is available per single crystal as the crystal frequency is increased. Hence, the receiver provides roughly 30 kHz of coverage at 14 MHz, owing to the 17.6-MHz crystal frequency. The transmitter covers approximately 19 kHz with the 14-MHz crystal. I set my frequencies to cover the lower portion of the Extra Class cw segment, but crystals can be chosen to yield coverage in any part of the band. I have a second crystal pair that provides operation in the General class part of the 20-meter cw band. The four crystals enable me to receive from 13.999 to 14.060 MHz. I can transmit from 14.000 to approximately 14.038 MHz.

The crystals are cut for a load capacitance of 30 pF and should be of the fundamental-mode type. Although overtone crystals can be used on the fundamental mode, they do not provide as great a frequency swing as fundamental-cut crystals do. An AT-cut crystal in an HC-6/U style of holder is recommended for VXO use. FT-243 crystals are not suggested for these circuits.

The innovator may wish to experiment with the VXOs to extend the tuning range. This can be done by increasing the inductance placed in series with the crystals. But, a point will be reached where the oscillator becomes a VFO rather than a VXO (with swings in excess of 100 kHz). The rock-stable quality will be lost, however.

The upper range of crystal oscillation with these circuits will always be higher than the marked frequency of the crystal — approximately 15 kHz higher for the receiver and about 8 kHz for the transmitter. This should be considered when ordering crystals. Furthermore, no two crystals ground for a given frequency will yield exactly the same operating characteristics in terms of frequency limits and range.

The VXO tuning response is nonlinear. The low-frequency end of the range is spread out, but the high-frequency part of the range is bunched up, so to speak. A vernier drive is recommended for the receiver VXO, but direct drive is adequate for adjusting the transmitter VXO.

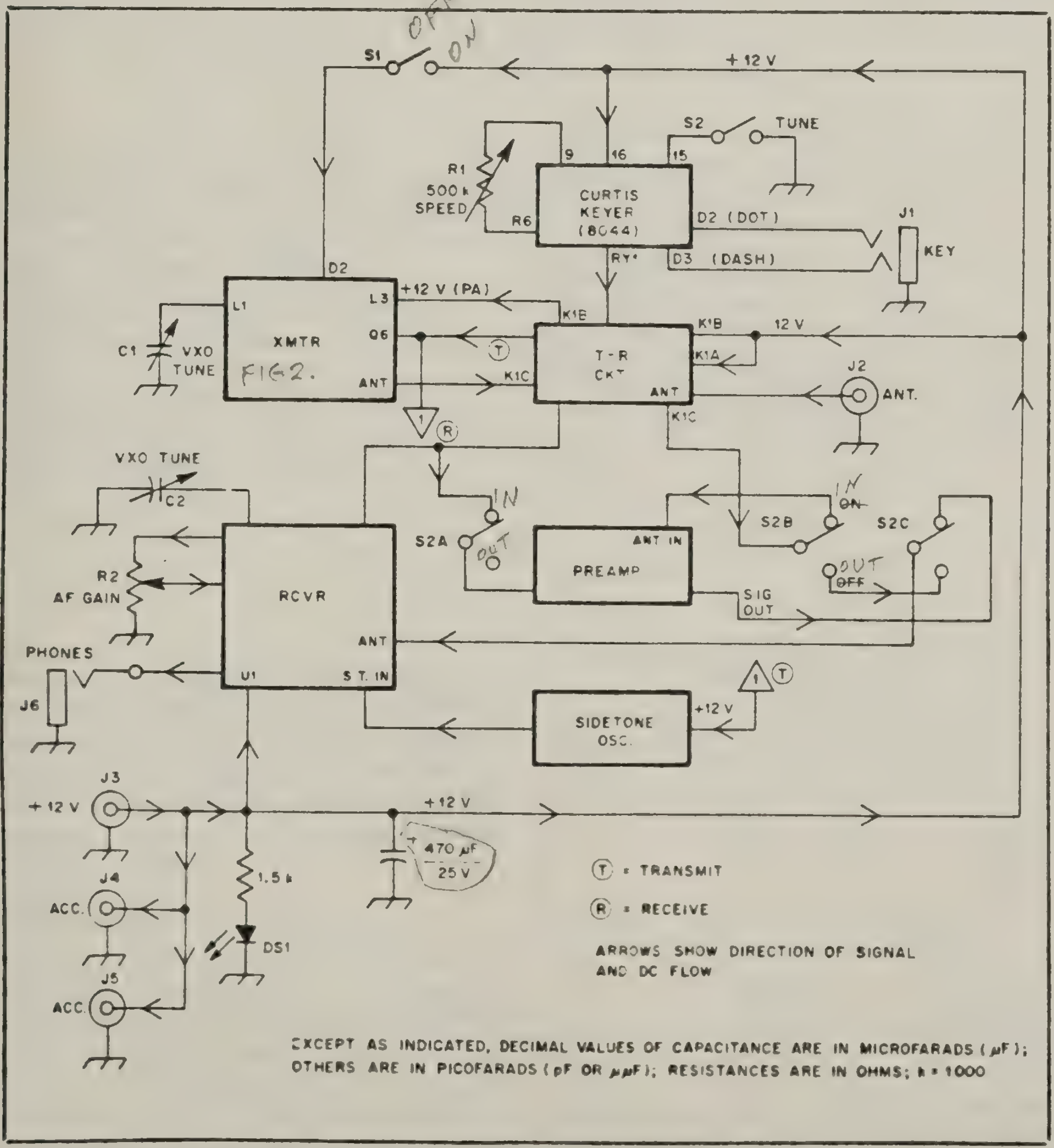


Fig. 1 — Block diagram of the trans-receiver showing how the modules are associated with one another. DS1 is a green panel-mount LED from Radio Shack. It serves as an on-off indicator. R1 and R2 are located on the front panel of the unit. The VXO tuning controls (C1 and C2) are available from the front panel.

Receiver Preamplifier

Although the basic receiver is not a monument to sensitivity and dynamic range, it is satisfactory for most 20-meter operation. I added a MOSFET preamplifier for use during weak-signal reception (Fig. 3). The primary advantage is an increase in overall receiver gain, with a noticeable improvement in noise figure. The preamplifier can be switched out of the antenna line for routine operation. I used a circuit kit that is available from Circuit Board Specialists (see note 3).

T-R Break-In Circuit

Break-in delay is provided by means of the circuit in Fig. 4. The module was developed by WA0UZO for use as a COR (carrier-operated relay) in repeaters. It has the advantage of not "hot switching" the PA stage of the transmitter. Hence, the antenna is connected to the PA before drive reaches the MRF476s. Hot switching can destroy the PA transistors over a period of time, and it can send out a momentary transient or "blurp" that may cause interference to other amateurs who are sharing the band.

Variable time delay has been provided by virtue of a pc-board control. The drop-out period can be lengthened by changing the 22-µF capacitor at pins 7 and 8 of the IC to a larger value. The components specified in Fig. 4 will permit a maximum delay of roughly 2 seconds. Minimum delay is 0.2 second.

A CD4093 quad, two-input Schmitt-trigger IC is the heart of the T-R circuit. As configured, the circuit permits the relay to close (transmit initiate) and the receiver to turn off instantly. Roughly 5 ms later, the transmitter is actuated, preventing unwanted hot switching. When the cw key is left up beyond the delay period, the relay opens and the receiver is actuated 5 ms later.

A 2N2222 serves as a relay driver, and two bipolar pnp switches are used for additional T-R control. The foregoing transistors are driven by the Schmitt trigger.

K1A in Fig. 4 is a surplus 12-V dc relay (135-ohm coil) from my junk box. Any similar dpdt relay can be used with the T-R circuit. For full QSK, the timing capacitor (22-µF) can be deleted and a reed relay (dpdt) or pair of reed relays (spdt each) substituted for K1. The reed relays will follow high-speed keying; standard relays won't. Various methods for full QSK are discussed in *Solid State Design for the Radio Amateur.*[4] The T-R circuit also keys the sidetone oscillator.

Sidetone Oscillator

Fig. 5 shows the circuit of the sidetone oscillator. The values given provide a frequency of 700 Hz with a clean wave. Out-

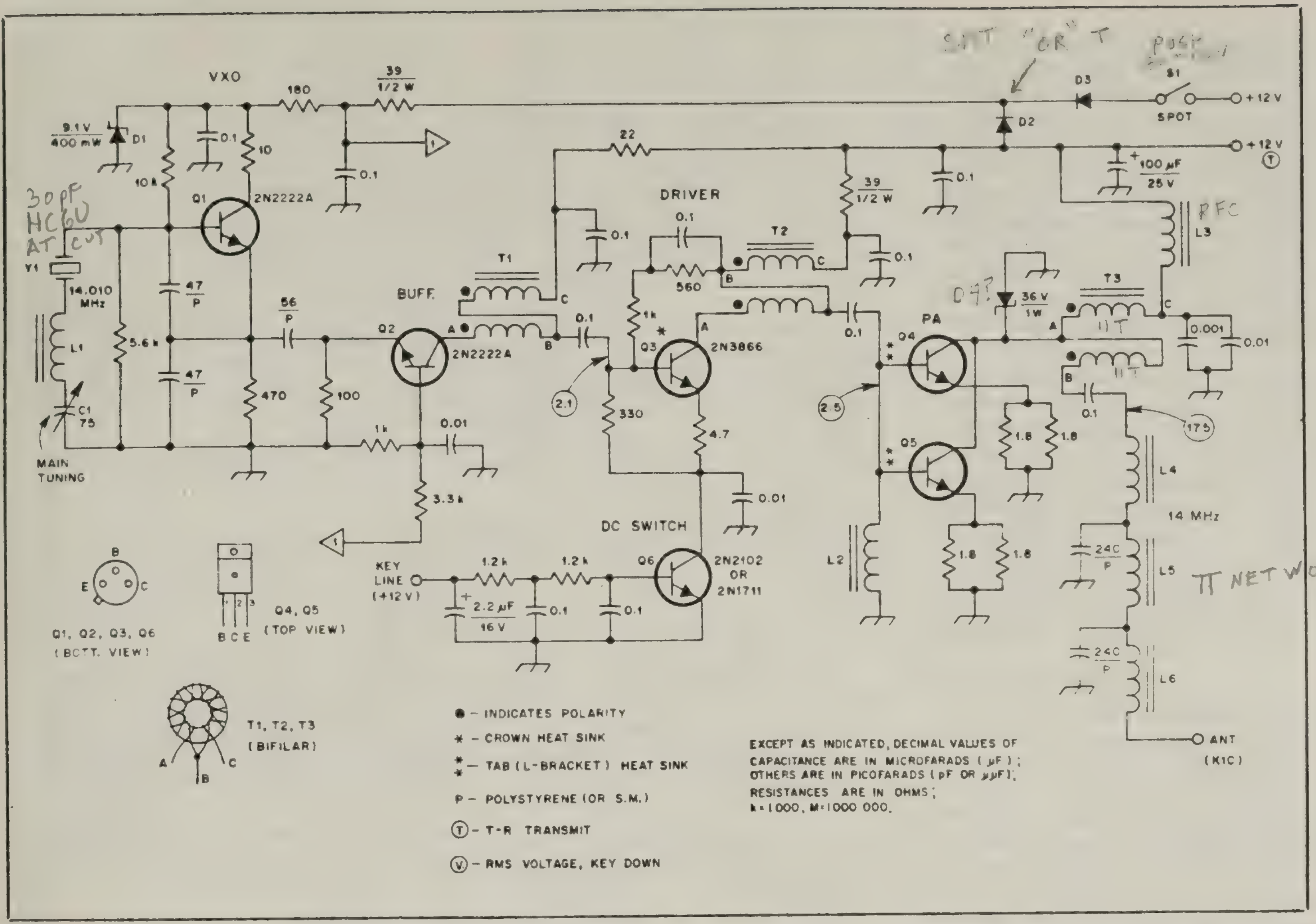


Fig. 2 — Schematic diagram of the modified W1VD 20-meter transmitter. Fixed-value capacitors are disc ceramic, unless otherwise noted. Polarized capacitors are tantalum or electrolytic. Fixed-value resistors are 1/4- or 1/2-W carbon-composition types, unless indicated differently.

C1 — Miniature 75-pF air variable.
D1, D4 — Zener diode regulator.
D2, D3 — 50-PRV, 1-A rectifier diode.
L1 — 43 turns no. 26 enam. wire on T50-6 toroid core (Amidon or Palomar Engineers), 7.5 µH.
L2 — Ferrite choke, 8 turns no. 26 enam. wire on an Amidon FB-73-801 jumbo bead.
L3 — Ferrite choke, 10 turns no. 24 enam. wire on an Amidon FT50-43 toroid.
L4, L6 — Toroidal inductor, 16 turns no. 24 enam wire on a T50-6 core.
L5 — Toroidal inductor, 19 turns no. 24 enam. wire on a T50-6 core.
Q4, Q5 — Motorola citizens band MRF476 transistor. Replaces discontinued MRF472 used in original W1VD circuit. Use homemade aluminum heat sink (small L bracket).
S1 — Push-button, momentary-on, panel-mount switch.
T1, T2 — Toroidal 4:1 broadband transformer. Use 11 bifilar turns no. 26 enam. wire on Amidon FT37-61 core.
T3 — Toroidal 4:1 broadband transformer. Use 11 bifilar turns no. 26 enam. wire on Amidon FT50-61 core.
Y1 — Fundamental 14-MHz range crystal, 30-pF load capacitance (see text). International Crystal Mfg. Co. type 434110, 10 N. Lee St., Oklahoma City, OK 73102.

3.16
1.50

put from the oscillator is routed to the op-amp audio-output stage of the receiver through a level control on the sidetone module. The audio-output amplifier is operational at all times, thereby permitting the sidetone to be heard during transmit periods.

Construction

There is plenty of latitude for packaging the trans-receiver. I chose a homemade cabinet that measures (HWD) 2-1/2 × 8 × 7 inches.[5,6] The cabinet bottom is a U-shaped piece of 16-gauge aluminum stock. The top cover is fashioned from a piece of aluminum cane metal that I bought at a hardware store. L brackets (two) are affixed to the inner edges (left and right) of the bottom half of the case. They provide anchor points for

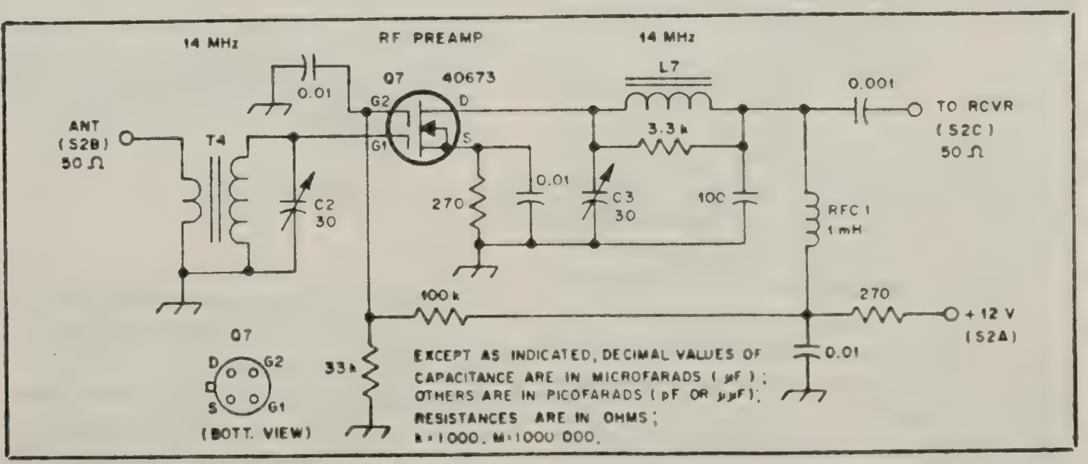

14 MHz
RF PREAMP
14 MHz
ANT (S2B) 50 Ω
T4
0.01
Q7 40673
G2
G1
D
S
C2 30
270
0.01
C3 30
L7
3.3 k
100
0.001
TO RCVR (S2C) 50 Ω
RFC 1 1 mH
100 k
270
+12 V (S2A)
0.01
33 k
Q7 (BOTT. VIEW)
EXCEPT AS INDICATED, DECIMAL VALUES OF CAPACITANCE ARE IN MICROFARADS (µF); OTHERS ARE IN PICOFARADS (pF OR µµF); RESISTANCES ARE IN OHMS; k=1000, M=1000 000.

Fig. 3 — Schematic diagram of the 20-meter receiver preamplifier. Fixed-value capacitors are disc ceramic. Resistors are 1/4- or 1/2-W carbon composition.

C2, C3 — Miniature 30-pF Mylar or mica trimmer, pc-board mount.
L7 — Toroidal inductor, 30 turns no. 28 enam. wire on a T37-2 core.
RFC1 - miniature RF Choke, 1 mH.
T4 — Toroidal rf transformer. Primary, 2 turns no. 28 enam. wire over ground end of secondary winding. Secondary contains 28 turns no. 28 enam. wire on a T37-2 core

KEY goes LOW FOR XMIT. D5 DISCH. 22μF, Q11 ACTUATES XMIT RELAY COIL. RC 10MS DELAYS U1A TO U1C THEN TURNS ON XMIT B+.

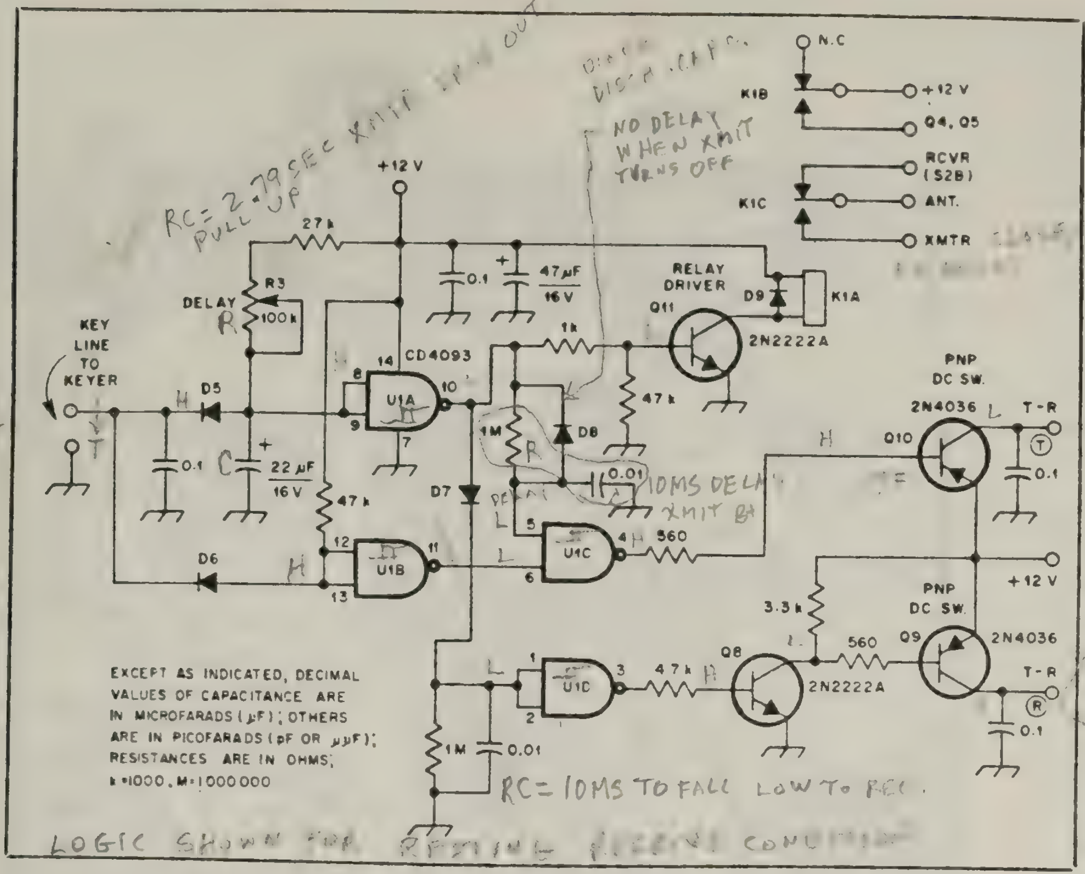


Fig. 4 — Schematic diagram of the break-in delay T-R circuit. Fixed-value capacitors are disc ceramic. The polarized capacitor can be tantalum or electrolytic. All diodes are small-signal silicon types, such as 1N914. K1 is a Magnecraft W67-RPC-X2 with a coil resistance of 135 ohms (see text). R3 is a pc-board mount trimmer control.

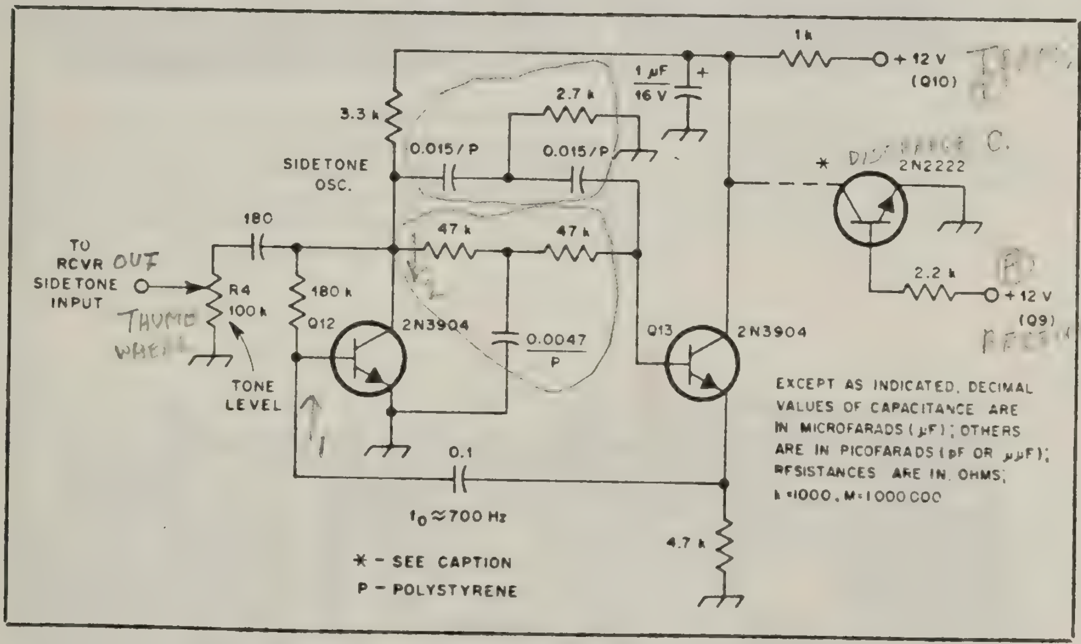


Fig. 5 — Schematic diagram of the twin-T sidetone oscillator for 700 Hz. Mylar or polystyrene style capacitors are suggested for best stability and Q. The polarized capacitor is tantalum or electrolytic. R4 is a pc-board mount trimmer control. The 2N2222 switch (optional) may be required to ensure fast turn off of the oscillator.

the lid, which is attached by means of two no. 6 sheet-metal screws per side.

The transmitter and receiver pc boards are supported above the chassis on 3/8-inch metal standoff spacers. All of the smaller boards are mounted on no. 4-40 screws, with two no. 4-40 nuts between the boards and the chassis to serve as standoff posts. A lock washer should be used at each mounting point to ensure good ground contact between the boards and the chassis. A view of the transreceiver innards is provided in Fig. 6. The revised transmitter is shown in Fig. 7.

RG-174/U miniature coaxial cable is used for all rf and audio wiring between the pc boards and the related panel jacks and controls. The shield braid of each cable should be grounded at each end. The dc connections are made with hookup wire that has been routed under the pc boards in bundles after being bound with lacing cord. A 470-μF, 25-V capacitor (see Fig. 1)

is connected from the 12-V input

jack to ground at the rear apron of the case. This helps to ensure a low-impedance 12-V bus and aids stability.

I painted the front and rear panels dark green. The top cover is painted gray. Both painted sections were given two coats of polyurethane clear spray after the paint had dried for 48 hours. This was done to provide a tough outer coating, which is practically impervious to damage from bumps and scratches. Green 1/4-inch Dymo® tape labels were added to identify the jacks and controls.

Adhesive-backed plastic feet (four) are attached to the bottom of the unit. I bent a length of aluminum sheeting to a 30° angle and placed it under the front of the box to elevate the panel during operation (see title-page photograph).

A set of pc-board templates and parts-layout data can be obtained from ARRL by sending $2 and a large s.a.s.e. Pc-board details for the receiver section were published in June 1982 *QST*.

Setup and Operation

It is best to assemble and test each module before mounting the circuits in the cabinet and wiring them together. "Murphy," should he be lurking in the background, can be unmasked early by this means. A scope or earphones will suffice when testing the sidetone oscillator. The T-R module can be checked by grounding the key line and observing the action of K1A.

Transmitter evaluation is accomplished by placing an output indicator (VSWR meter or wattmeter) between the PA and a 50-ohm dummy load. VXO range can be monitored on a station receiver, as can the quality of the keying. The approximate power output is determined by attaching a 2-W, 51-ohm resistor at the transmitter output terminal, closing the key (momentarily!) and measuring the rms voltage across the resistor by means of a scope or rf probe and VTVM. Power output should be between 6 and 8 W, depending on the supply voltage used. The power can be determined from

$$W = \frac{E^2}{R} = \frac{19^2}{51\Omega} \approx 7W \qquad \text{(Eq. 1)}$$

where E is in rms volts, and R is in ohms. Hence, if the load was 51 ohms and the developed voltage across the load was 19, the output power would be 7 W. Key-down current drain should be under 1.5 A. My unit draws roughly 1.3A.

The rf preamplifier can be tested and tuned by connecting it temporarily to the main station receiver. The gain, as noted on the S meter (relative) should be between 10 and 15 dB if all is as it should be. There must be no popping or blank carriers heard in the receiver as the amplifier is peaked. If there are some spurious responses, the preamplifier is unstable. If so, make sure the bypass capacitors are

not defective and that all wiring is correct

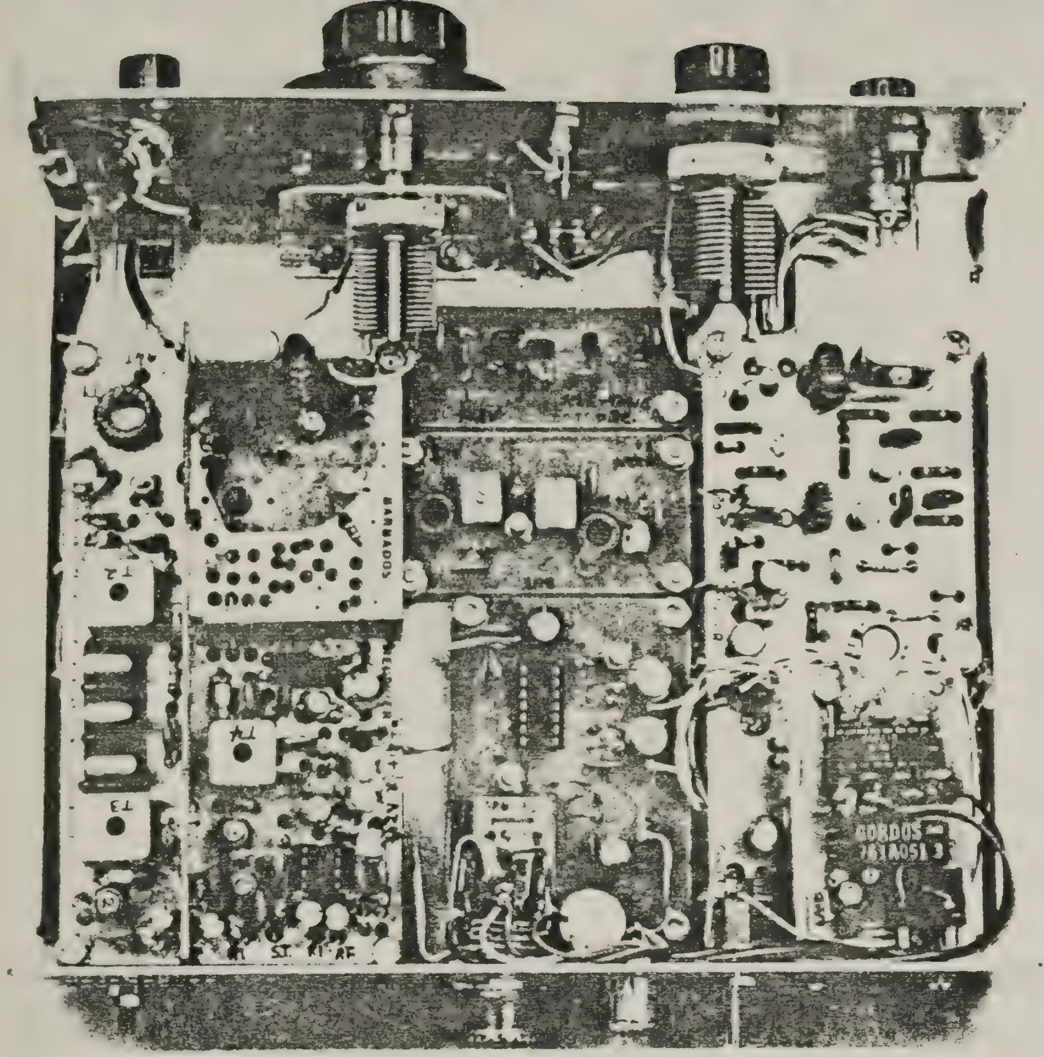


Fig. 6 — Interior view of the assembled trans-receiver. The receiver is at the far left. In descending order from the top center are the sidetone oscillator, the rf preamplifier and the break-in delay modules. At the lower right is the Curtis keyer, mounted on an L bracket above the transmitter pc board. The transmitter shown in this view is an original W1VD unit to which the modifications described in the text have been added. Fig. 7 shows the new transmitter board with a revised pattern and layout. The carrier-lock (tune) switch is located on the rear panel of the rig.

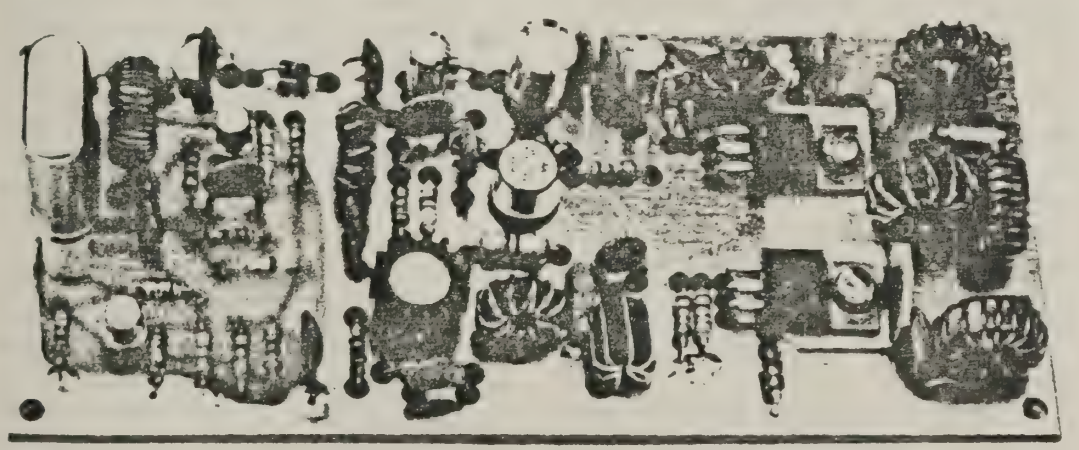


Fig. 7 — Photograph of the revised transmitter. Homemade heat sinking is provided for the PA transistors (far right). A crown heat sink should be placed on the driver transistor (board center). The ground foil has been etched away from the immediate area of the VXO to minimize stray capacitance and increase the crystal range.

Spurious responses will indicate self-oscillation. Only a smooth peak in received signal should be noted.

Results

W1FB while using a Cushcraft A4 triband Yagi antenna at 50 feet. Countless stations answered my CQs and gave reports ranging from RST 569 to 599. Frankly, I could discern no difference in my success station transceiver (100-W output). I worked numerous European stations, and the JAs were easy to work too, when band conditions provided a good path. I was pleased when some operators asked what brand of gear I was using; they were interested because the cw note sounded so good! Many were amazed to learn the unit was homemade and that it put out only 7 W! This points out the value of proper cw waveform shaping, a trick that has not been learned by all of the commercial manufacturers. A 5-ms rise-and-fall time is the target value to shoot for.

On April 2, 1982, the little rig was packed and taken to St. James, Barbados, W.I., for a two-week holiday. The primary rig was a Ten-Tec Argosy, which operated at approximately 50 W during the 8P6EU, 8P6FJ, WB1FSB/8P6 operation. The 20-meter antenna was a sloping dipole over the seashore, the top end of which was some 35 feet above the beach. Excellent results, worldwide, were obtained with both rigs, and no operator could detect a signal difference in transmitters when I made unannounced switches during QSOs. Fortunately, we did not have to rely on the QRP trans-receiver as a backup, for the Argosy percolated nicely from 80 through 10 meters. But, I had a lot of fun with the small rig while testing its effectiveness from a DX location.

Tag Ends

It is entirely possible that the trans-receiver could be modified easily for use on 15 meters and, probably, for 40 meters. The shortfall on 7 MHz would be limited frequency shift with the VXO, but on 15 meters it should match that for 20 meters. I have not explored these possibilities and have no practical data to offer. A skilled experimenter should have no trouble with such a project.

The packaged unit could be made much smaller than the example in this paper. If the pc boards were mounted on end (vertically), that would be a step in the right direction. Or, some of the boards could be stacked atop one another. One might even include an SWR indicator and Transmatch in the cabinet.

If you're a traveling ham, this may be the rig you need. It will accompany me on many business trips, vacations and camping trips in the future. The unit may be little — but it's *loud!*

Notes

[1] D. DeMaw, "Build a Bare-Bones CW 'Superhet,'" *QST*, June 1982.

[2] J. Rusgrove, "A 20-Meter, VXO-Controlled, 6-Watt Transmitter," *QST*, Dec. 1978.

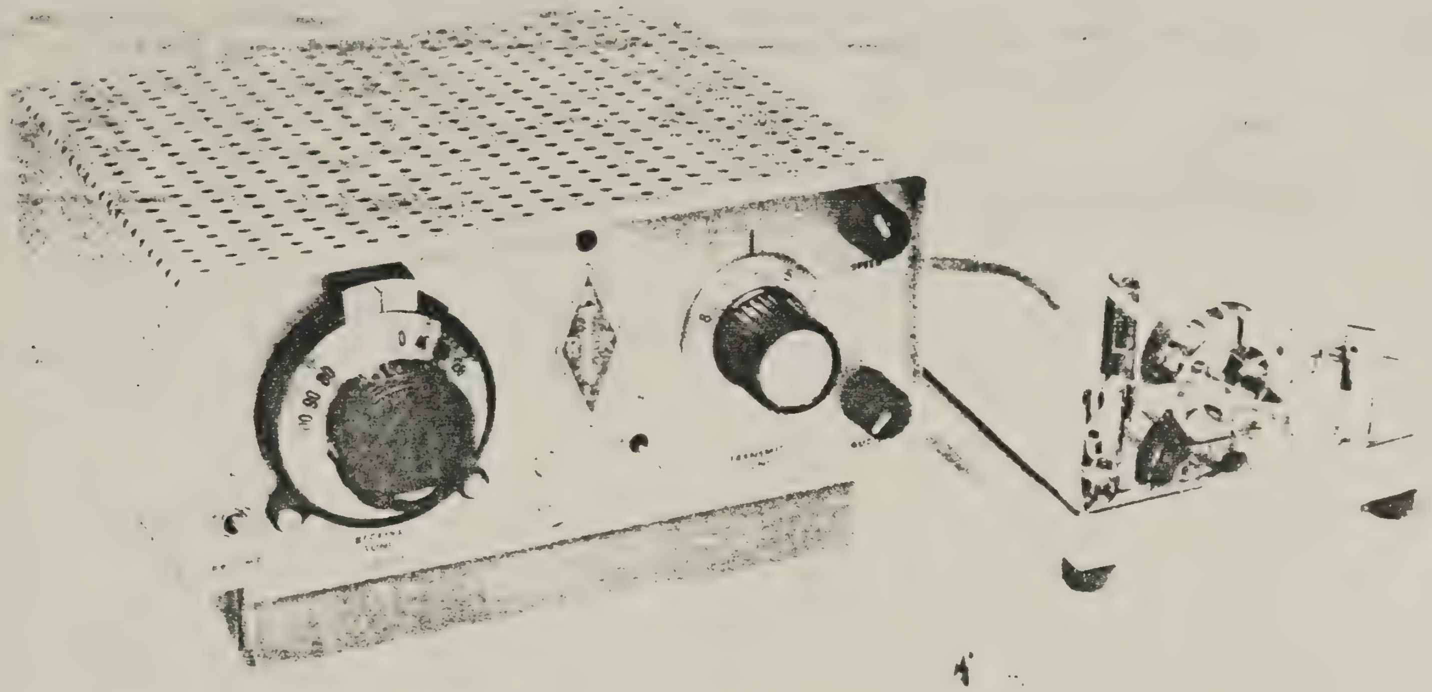
[3] Negatives, circuit boards and complete parts kits for this trans-receiver are available from Circuit Board Specialists, P.O. Box 969, Pueblo, CO 81002, tel. 303-542-5083.

[4] W. Hayward and D. DeMaw. Published by ARRL, Inc., Newington, CT 06111.

[5] See title-page photograph. A case made from double-sided pc-board material would serve nicely in place of the aluminum one shown.

APRIL '83 QST

Putting the "8P6 Special Hamcation Rig" on 10 MHz



No gear for 30 meters? Here's your chance to get on the new WARC band with an inexpensive homemade trans-receiver.

By Doug DeMaw,* W1FB

I've been "hounded" for conversion information ever since the 20-meter "Hamcation Special" appeared in November 1982 *QST*. Amateurs have been asking how they might convert the 20-meter trans-receiver for use at 10 MHz. The changes are simple, and a kit of parts is available by mail.[1]

Transmitter Modification

Owing to the broadband circuits in the transmitter section of the portable station, there is little to do in order to convert the rf strip from 14- to 10.1-MHz operation. The crystal for the VXO is selected for the upper or lower segment of the band (remember that 10.109 to 10.115 MHz is an amateur "no man's land"; we can't operate there!). The VXO provides approximately 10 kHz of frequency swing when using a 10.1-MHz crystal. L1, the toroidal inductor that connects between Y1 and tuning capacitor C1 of Fig. 1, is made larger. The new inductance value is 12 µH.[2]

10.105? 30'

The capacitors and inductors of the PA output filter must also be changed in value. Pertinent data are given in Fig. 1. No other changes are required in the transmitter section of the rig. Power output from the MRF476s is the same as for 14-MHz operation — 7 to 8 watts into a 50-ohm load while using a 13.5-volt dc power supply.

Receiver Circuit Changes

T4, L7, C2 and C3 of Fig. 2 (preamplifier module) need to be changed to new values. No additional modifications are necessary for this subassembly.

Two areas require attention in the "Bare Bones CW Superhet" receiver.[3] The VXO crystal (Y4 of Fig. 3) is ground for operation at approximately 13.6 MHz (depending on the band segment desired). The VXO inductor (L1) is increased in value to 10 µH (see note 2).

The remaining receiver-circuit change involves rewinding T1 at the mixer input and adjusting C1 to provide resonance at 10.1 MHz. There are no other changes to the receiver circuit. Simple, eh?

Some Band Aids

Some versions of the original circuit from November 1982 *QST* developed minor "bugs." One condition became manifest as a short-term howl in the earphones as the break-in-delay circuit dropped out of the transmit mode. This was traced to momentary self-oscillation of the receiver mixer during the transfer period of the T-R relay. At that time the receiver remains activated, but there is no load connected to the mixer input. Oscillation occurs at the intermediate frequency (3.579 MHz) because of the high Q reflected to the mixer by the crystal filter. The simple cure is to add a 270-ohm, 1/4-watt resistor (R1) from the high side of the T1 link winding to ground (Fig. 3). This maintains an adequate load at all times, but is high enough in value to prevent degradation of the receiver sensitivity.

Another problem reported by some operators is a missing first dot or dash when the keyer is actuated. This can result

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[1] Notes appear on page 21.

*QST Senior Technical Editor

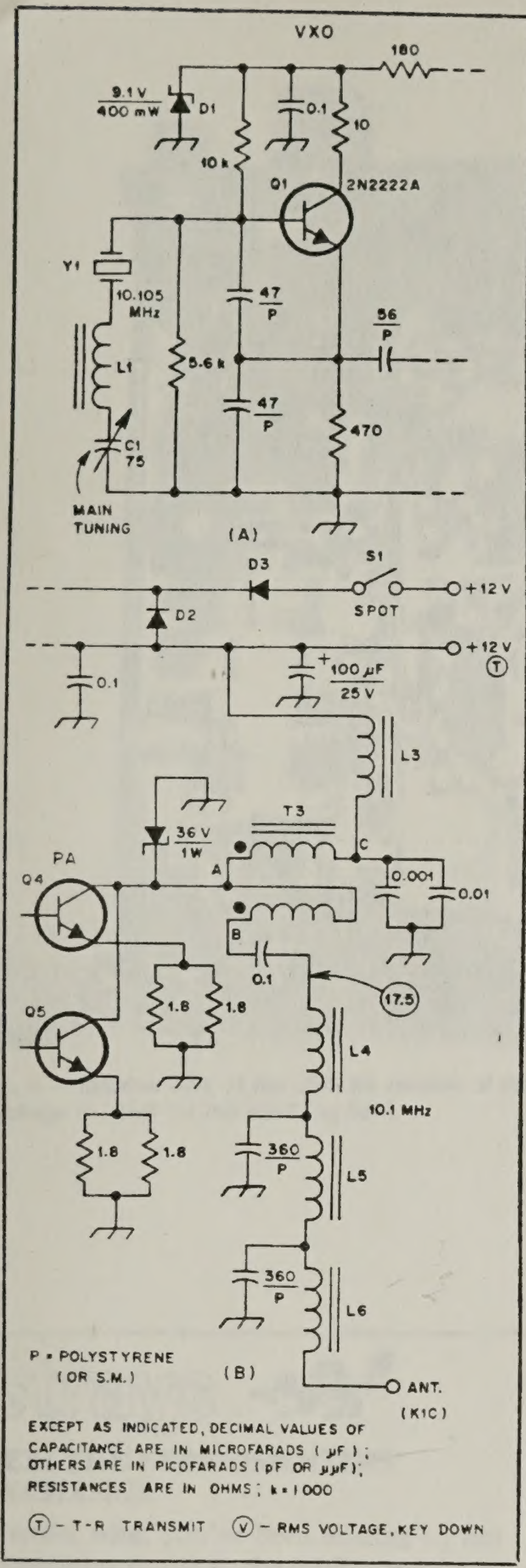


Fig. 1 — The diagram at A shows the transmitter VXO. Y1 is changed to 10.105 MHz for approximate coverage from 10.100 to 10.110 MHz, the lower segment of the 30-meter band. Y1 is an International Crystal Mfg. Co. no. 434110 fundamental crystal. The new L1 value is 12 μH (50 turns of no. 28 enam. wire on an Amidon or Palomar T50-2 toroid core). At B is the PA section of the transmitter. The new cutoff frequency for the harmonic filter is 11.67 MHz. L4 and L6 are rewound to provide an inductance of 0.5 μH (11 turns of no. 24 enam. wire on a T50-6 toroid core). L5 is 1.0 μH (16 turns of no. 24 enam. wire on a T50-6 core).

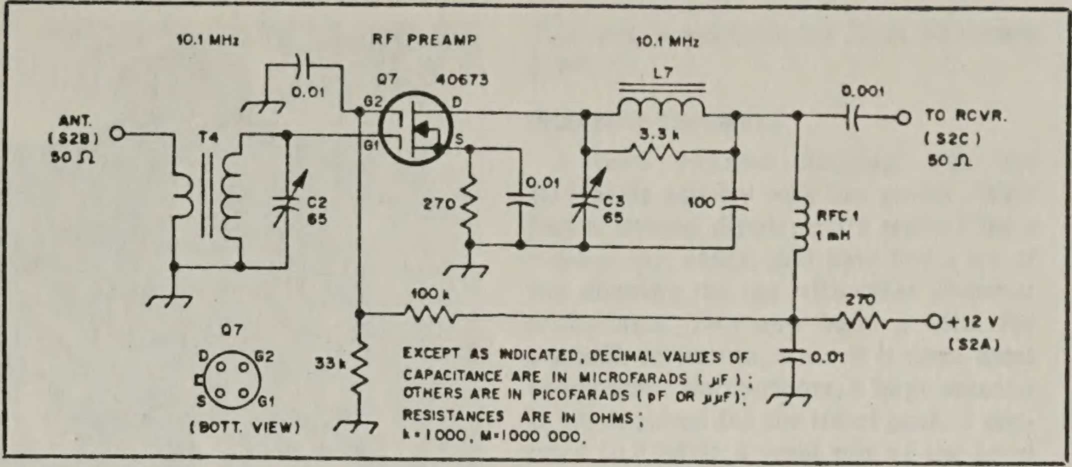

10.1 MHz
RF PREAMP
10.1 MHz
0.01
Q7
40673
L7
0.001
G2
D
ANT.
(S2B)
50 Ω
T4
G1
S
3.3 k
TO RCVR.
(S2C)
50 Ω
C2
65
270
0.01
C3
65
100
RFC1
1 mH
100 k
270
+12 V
(S2A)
Q7
D
G2
S
G1
(BOTT. VIEW)
33 k
0.01
EXCEPT AS INDICATED, DECIMAL VALUES OF CAPACITANCE ARE IN MICROFARADS (μF); OTHERS ARE IN PICOFARADS (pF OR μμF); RESISTANCES ARE IN OHMS; k = 1000, M = 1000 000.

Fig. 2 — Circuit of the modified preamplifier. C2 and C3 are changed to 65 pF, or the existing ones can be shunted by fixed-value capacitors to provide resonance at 10.1 MHz. T4 is rewound to contain 34 turns of no. 28 enam. wire on a T37-2 toroid core. The link has 3 turns. L7 has 36 turns of no. 28 enam. wire on a T37-2 core.

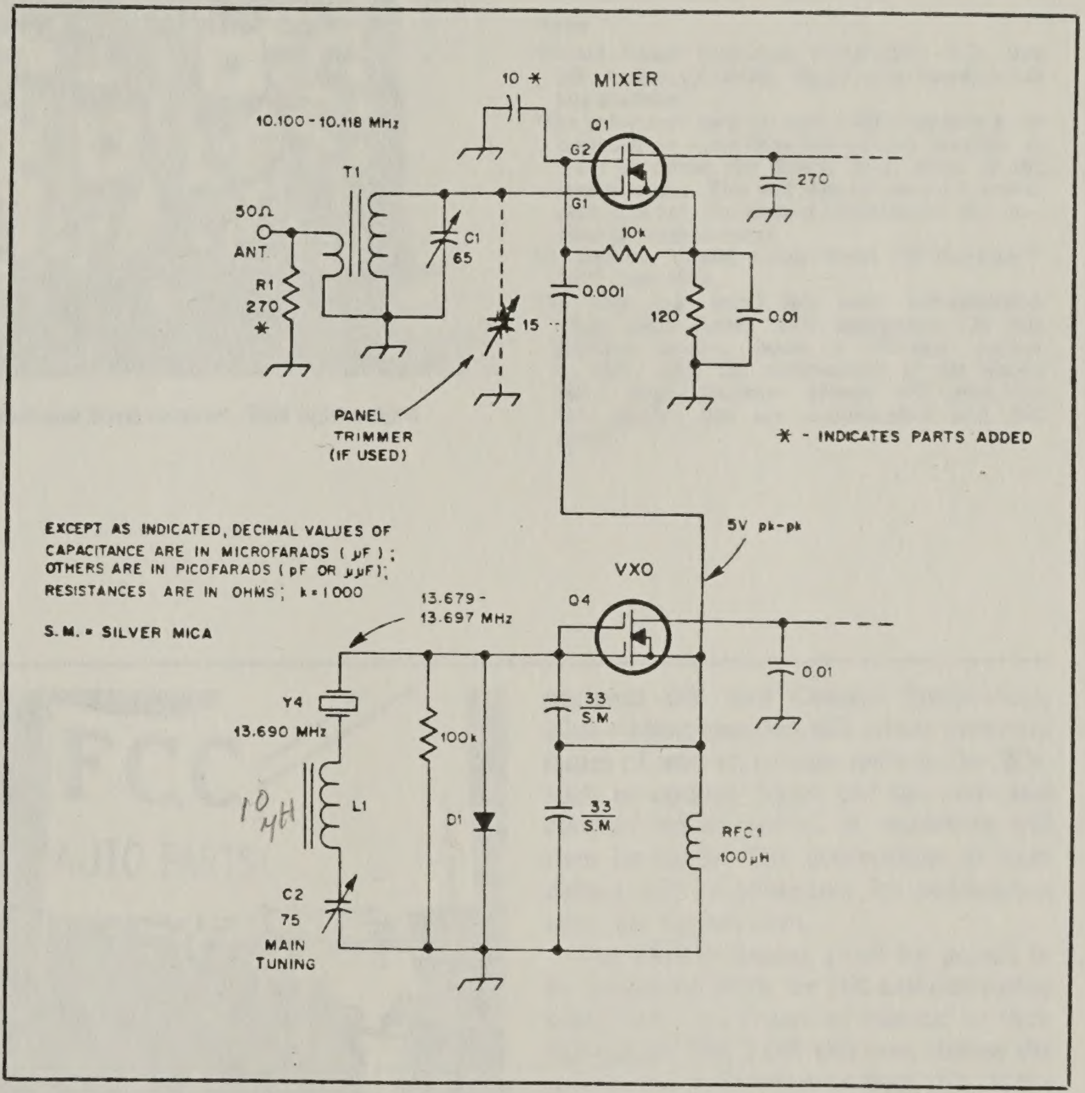


Fig. 3 — The mixer and VXO sections of the 10.1-MHz receiver. R1 is added (see text) to cure a momentary instability problem in the mixer. A 10-pF capacitor has been added at gate no. 2 of Q1 to drop the LO injection from 10 volts pk-pk to 5 volts pk-pk. Y1 is changed to a 13.690-MHz unit for coverage from 10.100 to 10.118 MHz (the low segment of 30 meters). It is an International Crystal Mfg. Co. type 434110, fundamental cut. L1 is changed to a value of 10 μH (50 turns of no. 30 enam. wire on a T50-6 core). T1 is modified to contain 35 turns of no. 26 enam. wire (5 μH) on a T50-2 core. The link has 4 turns of no. 26 wire.

from 2.2-μF blocking capacitor between the gain control and pin 2 of the TL081 op amp holding a charge, which locks out the sidetone signal on the first dit. Substitution of a 0.1-μF capacitor cured the malady.

If instability is noted in the 40673 i-f amplifier of the kit version of this transceiver, put a 0.1-μF bypass capacitor directly at gate 2 of the amplifier (foil side of board). No other unwanted "frigglies" have been reported.[4]

Kit Version

Circuit Board Specialists has developed the kit version of this trans-receiver, which is shown in the accompanying photographs. A single circuit board is used to contain all of the sections that were formerly on individual pc boards. They have also added a Curtis keyer to the new board. The assembled unit (less power supply) measures (HWD) 2-3/4 × 6-3/4 × 6 inches (70 × 171 × 152 mm).

This unit is available for 20 or 30 meters (note 1).

Summary Comments

I have enjoyed hopping into the 10.1-MHz activity with low power. With just a sloping dipole and 8 watts I have worked DX easily, and have had a lot of fun chewing the rag with other 30-meter enthusiasts. This new band is ideal for portable operation, since it is open most of the time. Furthermore, a large antenna is not required for the travel pack. I consider 10.1 MHz a great mix of the good qualities of 40 and 20 meters — perfect for the briefcase rig I like to carry afield!

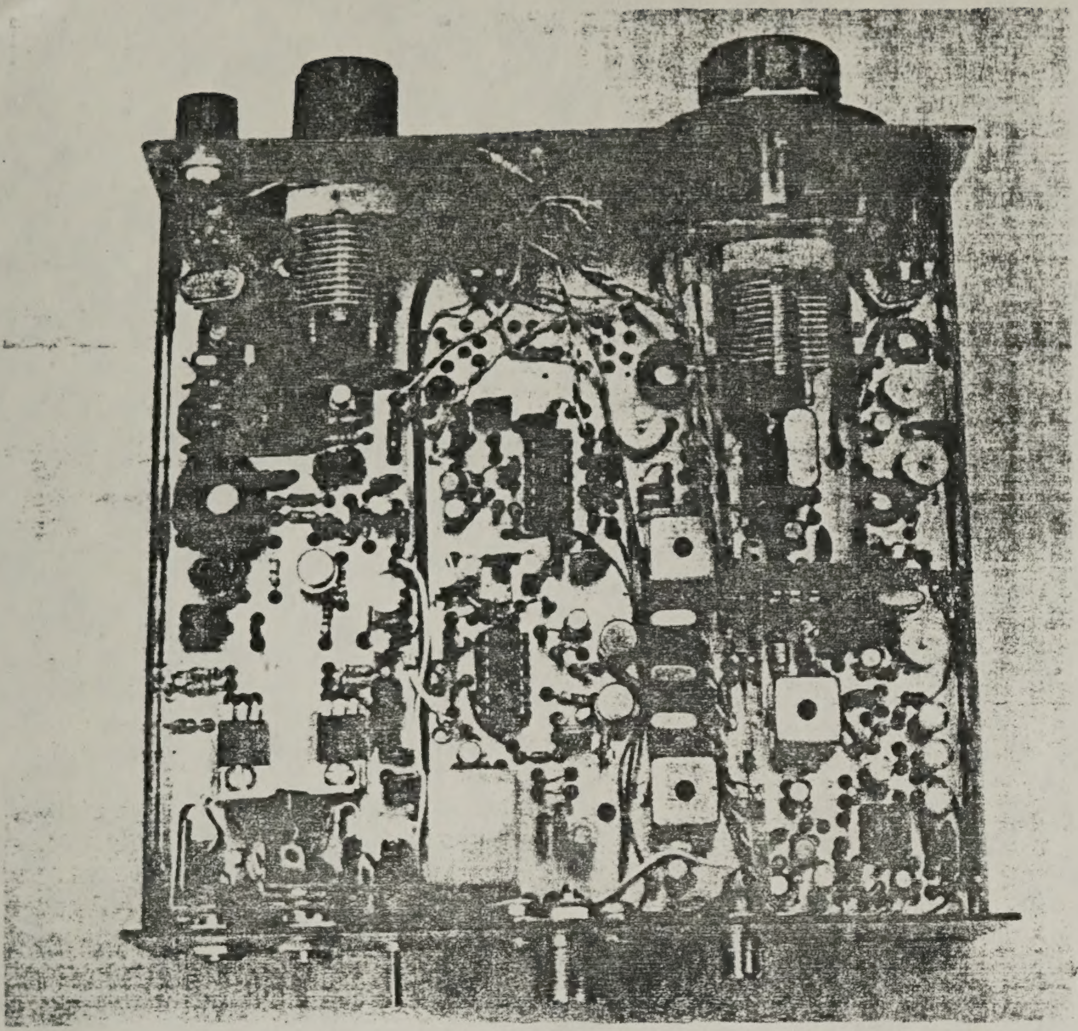


Fig. 4 — Interior view of the CBS kit version of the 30-meter trans-receiver. This lightweight package is ideal for the traveling ham.

Notes

[1] Circuit Board Specialists (WA0UZO), P.O. Box 969, Pueblo, CO 81002. Negatives, pc boards or full kits available.

[2] The inductance value in both VXOs may have to be increased to more than the amount specified in order to obtain the desired lower limits of the tuning ranges. This will depend upon the crystal used. Use only the amount of inductance that provides the desired range.

[3] D. DeMaw, "Build a Bare Bones CW Superhet," *QST,* June 1982.

[4] Op amps may break into audio self-oscillation when using 8-ohm hi-fi headphones. If this problem occurs, insert a 100-ohm resistor in series with the audio-output at the phone jack. High-impedance phones will give the best results, and are recommended with this circuit.

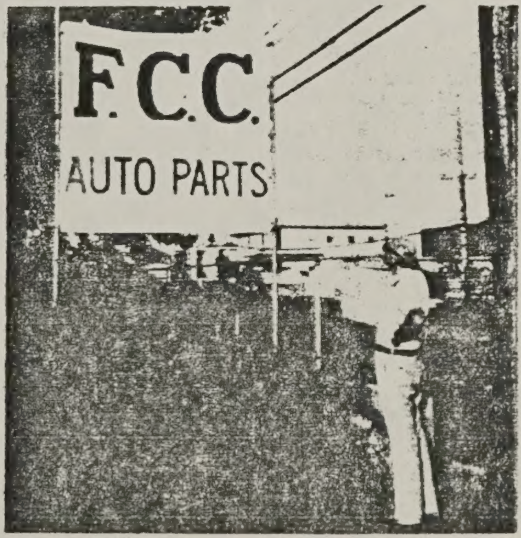
Strays

QEX: THE EXPERIMENTERS' EXCHANGE

Wonder what you've been missing by not subscribing to *QEX,* the ARRL newsletter for experimenters? Among the features in the March issue were:

- More on the Second ARRL Packet Conference
- "Packet Radio and Radio Communication Requirement," by Karl Meinzer, DJ4ZC
- "A Bibliography on Minimum-Shift Keying," by Den Connors, KD2S
- "ZX81 RTTY Receive Program," by Brian Davis, W9HLQ
- "Data Communications — Digital Phase Lock Loops," by David Borden, K0MMO
- "Components," by Mark Forbes, KC9C

QEX is edited by Paul Rinaldo, W4RI, and is published monthly. The special subscription rate for ARRL members is $6 for 12 issues; for nonmembers, $12. There are additional postage surcharges for mailing outside the U.S.; write Headquarters for details.



No, the FCC is not in the auto parts business, as this sign on Guam seems to indicate to ARRL President Vic Clark, W4KFC, who visited the island last year. *(tnx AH2A)*

CALL FOR PAPERS

☐ The 1983 ARRL National Convention, to be held in Houston, Texas, on October 7-9, will have a new wrinkle for DXers and contesters. The Texas DX Society is inviting leading DXers and contesters worldwide to participate in the First International DX and Contest Symposium. Blue-ribbon panelists will debate pertinent issues of interest to ham radio in the '80s, such as contest ethics and the pros and cons of list operation. A resolution will then be made. The proceedings of each debate will be submitted for publication after the Convention.

The TDX is issuing a call for papers to be submitted from the DX and contesting community on topics of interest to each individual. The TDX will then choose the papers that best represent each side of the most popular issues. These papers will be read and credited to the amateurs who submit them. All contributors whose papers are chosen for presentation will be notified in advance. The papers, one typewritten page on any DX or contest topic, should be submitted by June 1, 1983 to Bob Evans, N5DU, Symposium Coordinator, 13719 E. Cypress Forest, Houston, TX 77070.

I would like to get in touch with . . .

☐ any hams who were members of the 40th Mobile Communications Squadron or the 21st Weather Squadron during WW II. Irvin J. Kirch, W9YFG, 34 Hoss Rd., Indianapolis, IN 46217.

This rig is suitable for 20 or 30 meters (Note 1).

Summary; Conclusions

I have enjoyed [illegible] into the 10.1-MHz activity with low power. [illegible] had a [illegible] [illegible] and [illegible] I have worked DX easily, and have had a lot of fun chewing the rag with other [illegible] enthusiasts. This new band is ideal for portable operation, since it is open most of the time. Furthermore, a large antenna is not required for the travel pack. I consider 10.1 MHz a great mix of the good qualities of 40 and 20 meters — perfect for the briefcase rig I plan to carry wherever I go.

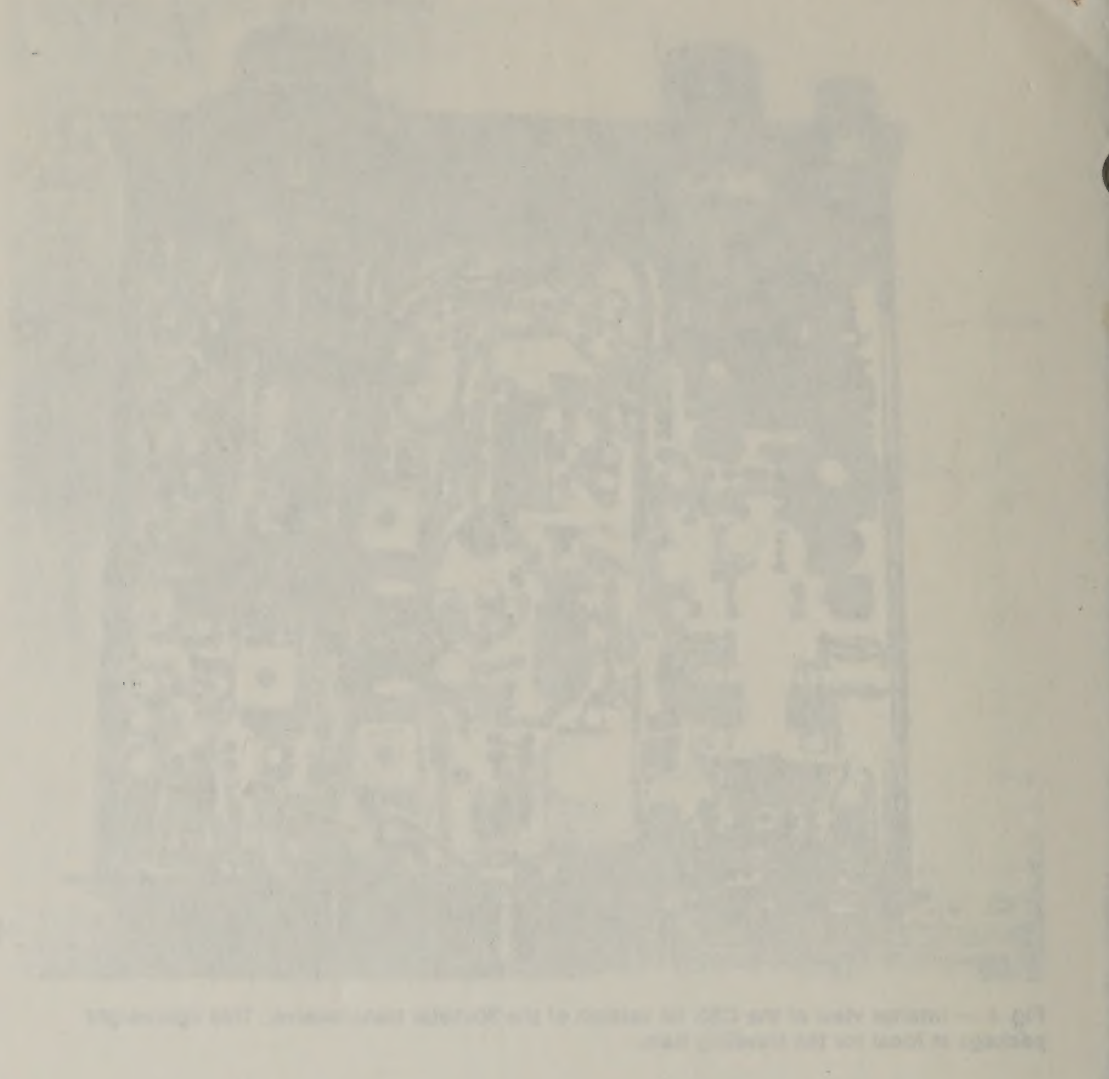


Fig 4 — Interior view of the [illegible] version of the 30-meter travel [illegible]. This rig [illegible] package is ideal for the traveling ham.

Notes

[1] [illegible]

[2] [illegible]

[3] [illegible], "Build a [illegible] CW [illegible]," QST, June 1983.

[4] [illegible]

Strays

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- "Components," by Mark Forbes, [illegible]

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You, the FCC, is big in the ham radio business, as this sign in [illegible] seems to indicate to ARRL [illegible] who visited the [illegible]

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I would like to get in touch with . . . [illegible] who were members of the [illegible] Mobile Communications Squadron of the [illegible] during WW II. [illegible] J. Klein, W9[illegible], [illegible] Rd., Indianapolis, IN 46[illegible]